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SEED INTELLECTUAL PROPERTY LAW GROUP PLLC
701 FIFTH AVE
SUITE 5400
SEATTLE, WA 98104

EXAMINER	
BECK, ALEXANDER S	

ART UNIT	PAPER NUMBER
2629	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/811,310	BERKLEY ET AL.	
	Examiner	**Art Unit**	
	ALEXANDER S. BECK	2629	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 03 June 2009.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-9,12-15,17-30,33,38,39,42,49-55 and 57-73* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *18-25,29,30 and 33* is/are allowed.

6)☒ Claim(s) *1-3,5-9,12-15,17,26-28,38,39,42,49-54,57-65 and 67-73* is/are rejected.

7)☒ Claim(s) *4,55 and 66* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *24 March 2004* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

RESPONSE TO AMENDMENT

1. Acknowledgment is made of the amendment filed June 3, 2009 ("Amend."), in which the rejections of the claims are traversed. Claims 1-9, 12-15, 17-30, 33, 38, 39, 42, 49-55 and 57-73 are currently pending and an Office action on the merits follows.

CLAIM REJECTIONS - 35 USC § 103

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

3. Claims 9, 38, 49, 51, 60-65 and 69 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,305,429 to Sato et al. ("Sato") in view of U.S. Patent No. 6,879,315 to Guy et al. ("Guy").

As to claim 9, Sato discloses a haptic interface device to provide haptic interaction to a user manipulating a tool, the haptic interface device comprising: an attachment point (Sato, 10) configured to receive the tool; a plurality of not more than four cables (Sato, 12-1, 12-2, 12-3, 12-4), each cable coupled to a respective firs tend to the attachment point; and a plurality of tool translation effecter devices (Sato, elements 38, 40, 44, 46 and 48 provided at anchoring points for cables 12-1, 12-2, 12-3 and 12-4), each having

coupled thereto a second end of a respective one of the plurality of cables such that, as the attachment point moves relative to that tool translation effecter device, the cable coupled thereto is retracted or paid out accordingly, and to meter the cable as it is retracted and paid out (Sato, col. 4, ll. 6-56; see also col. 6, l. 6 – col. 7, l. 13).

Sato does not disclose expressly wherein each tool translation effecter device is configured to selectively vary an active tension on the cable coupled thereto, as claimed. Guy discloses a multiple degree of freedom force reflecting haptic interface device (Guy, Abstract), wherein instead of using mechanical linkages, gears, or other force transmission components, the interface employs dedicated actuators fitted with capstans and corresponding cables to power rotary axes (Guy, col. 4, ll. 55-58). These cable drives provide good force transmission characteristics with low weight (Guy, col. 4, ll. 58-59). Metering means are provided for metering the cables as they are retracted and paid out (Guy, col. 12, ll. 64-67). Furthermore, Guy discloses in the background of the prior art that under appropriate conditions, the interface can resist, balance, or overcome a user input force along a degree of freedom (Guy, col. 1, ll. 48-51). The powered axis may be active, with force being varied as a function of system conditions (Guy, col. 1, ll. 51-53).

At the time the invention was made, it would have been obvious to one skilled in the art to replace each of the four passive translation effecter devices in Sato (Sato, elements 38, 40, 44, 46 and 48 provided at anchoring points for cables 12-1, 12-2, 12-3 and 12-4) and metering means with the active translation effecter device and metering means taught by Guy. Thus, the combined teachings resulting in an active translation effecter device (e.g., powered cables) positioned relative to each other, such that each of the first, the second, the third, and the fourth tool translation effecter devices occupies a vertex of a tetrahedron. The suggestion/motivation for doing so would have been to provide good force transmission characteristics with low weight (Guy, col. 4, ll. 58-9). Furthermore, at the time the invention was made it would have been obvious to one skilled in the art to further modify the teachings of Sato and Guy such that under

appropriate conditions, the interface can resist, balance, or overcome a user input force along a degree of freedom with force being varied as a function of system conditions, as taught by Guy in discussing the background of the prior art (Guy, col. 1, ll. 48-53). As one of ordinary skill in the art would appreciate, the suggestion/motivation for doing so would have been to enhance user experience by varying a haptic force felt at the attachment point as a function of system conditions.

As to claim 49, all of the claim limitations have been discussed and met by Sato and Guy in the rejection of claim 9 above.

As to claim 51, Sato does not disclose expressly establishing means for establishing, during an initialization procedure, a distance between each of the tool translation effecter devices and the attachment point, as claimed. Guy discloses establishing means for establishing a location of the attachment point (Guy, col. 13, ll. 11-17). At the time the invention was made it would have been obvious to one skilled in the art to further modify the teachings of Sato, Guy and Massie such that establishing means were provided to establish a location of the attachment point as taught by Guy. Thus, the combined teachings result in establishing a respective distance between each of the tool translation effecter devices and the attachment point (i.e., establishing a location of the attachment point). The suggestion/motivation for doing so would have been to include automatic work volume calibration for initializing a position of the haptic interface when the system is energized (Guy, col. 13, ll. 11-17).

As to claim 38, Sato is modified by Guy for the same reasons set forth in the rejection of claim 9 above, and therefore teaches/suggests a method, comprising: selectively applying active tension to each of four cables (Sato, 12-1, 12-2, 12-3, 12-4) (Guy, col. 1, ll. 48-51; see also col. 4, ll. 55-59), each cable having a first end coupled to

a tool (Sato, 10) and having a second end coupled to a respective vertex of a tetrahedron such that, as the tool is moved closer to any of the vertices the respective cables are drawn in at the respective vertices, thereby shortening the respective cables, and as the tool is moved away from any of the vertices the respective cables are fed out from the respective vertices, thereby lengthening the respective cables; tracking changes in length of each of the four cables; and deriving a change of position of the tool on the basis of tracked changes in length of each of the four cables (Sato, col. 4, ll. 6-56; see also col. 6, l. 6 – col. 7, l. 13) (Guy, col. 12, ll. 64-67).

As to claim 60, Sato does not disclose expressly establishing a length of each of the four cables by positioning the tool at a calibration point from which the respective lengths of each of the four cables is known, as claimed. Guy discloses establishing a position of the tool by positioning the tool at a calibration point from which the position is known (Guy, col. 13, ll. 11-17). At the time the invention was made it would have been obvious to one skilled in the art to further modify the teachings of Sato and guy such that the position of the tool was established by placing the tool at a calibration point as taught by Guy. Thus, the combined teachings result in establishing a length of each of the four cables by positioning the tool at a calibration point from which the respective lengths of each of the four cables is known (i.e., establishing a location of the tool). The suggestion/motivation for doing so would have been to include automatic work volume calibration for initializing a position of the haptic interface when the system is energized (Guy, col. 13, ll. 11-17).

As to claim 61, Sato as modified by Guy teaches/suggests selecting a value of active tension applied to each of the four cables on the basis of a selected force response feedback to be applied to the tool (Guy, col. 1, ll. 48-51; see also col. 4, ll. 55-59).

As to claim 69, Sato as modified by Guy teaches/suggests wherein the selected force response feedback is a selected force vector, and the selecting a value of active tension comprises optimizing, to be close to zero, a sum of (1) a difference between the selected force vector and a calculated target force vector and (2) a product, at least one factor of which is the values of active tension applied to each of the four cables (e.g., balancing) (Guy, col. 1, ll. 48-53).

As to claim 62, Sato is modified by Guy for the same reasons set forth in the rejection of claim 9 above, and therefore teaches/suggests a method, comprising: selectively applying active tension to a cable (Sato, 12-1, 12-2, 12-3, 12-4) having a first end and a second end, the first end of the cable coupled to a tool (Sato, 10) and the second end of the cable coupled to an anchor point (Sato, 14-1, 14-2, 14-3, 14-4) (Guy, col. 1, ll. 48-51; see also col. 4, ll. 55-59), as the tool is moved closer to the anchor point, winding the cable onto a spool; as the tool is moved away from the anchor point unwinding the cable from the spool; tracking a distance of the tool from the anchor point by counting fractional rotations of the spool as the cable is wound an unwound therefrom (Sato, col. 4, ll. 6-56; see also col. 6, l. 6 – col. 7, l. 13) (Guy, col. 12, ll. 64-67).

Sato does not disclose expressly limiting tracking errors introduced by changes in effective diameter of the spool as the effective diameter changes in response to the cable being wound an unwound therefrom, as claimed. Guy discloses limiting tracking errors introduced by changes in effective diameter of the spool as the effective diameter changes in response to the cable being wound and unwound therefrom (Guy, col. 4, l. 67 – col. 5, l. 3; see also col. 7, ll. 12-21). At the time the invention was made it would have been obvious to one having ordinary skill in the art to further modify the teachings of Sato and Guy such that tracking errors were limited, as taught by Guy. The suggestion/motivation for doing so would have been to limit slippage as the cables are wound and unwound (Guy, col. 4, l. 67 – col. 5, l. 3; see also col. 7, ll. 12-21).

As to claim 63, Sato as modified by Guy teaches/suggests wherein the cable is one of a plurality of cables having respective first and second ends, the first ends coupled to the tool and the respective second ends coupled to respective anchor points, and further comprising: winding each of the plurality of cables onto a respective spool as the tool is moved closer to the respective anchor point; unwinding each of the plurality of cables from the respective spool as the tool is moved away from the respective anchor point; tracking a distance of the tool from each of the respective anchor points by counting fractional rotations of each of the respective spools; and limiting tracking errors introduced by changes in effective diameter of each of the respective spools as the effective diameter changes in response to the cable being wound and unwound therefrom (Sato, col. 4, ll. 6-56; see also col. 6, l. 6 – col. 7, l. 13) (Guy, col. 4, l. 67 – col. 5, l. 3; see also col. 7, ll. 12-21; col. 12, ll. 64-67).

As to claim 64, Sato discloses wherein the number of cables in the plurality of cables is equal to three (Sato, 12-1, 12-2, 12-3); and the respective anchor points (Sato, 14-1, 14-2, 14-3) are positioned in a triangle that defines a plane in which the tool has freedom to move (Sato, Fig. 1).

As to claim 65, Sato discloses wherein the number of cables in the plurality of cables is equal to four (Sato, 12-1, 12-2, 12-3, 12-4); and the respective anchor points (Sato, 14-1, 14-2, 14-3, 14-4) are positioned at respective vertices of a tetrahedron position within a volume of space in which the tool has freedom to move (Sato, Fig. 1).

As to claim 70, Sato is modified by Guy for the same reasons set forth in the rejection of claim 9 above, and therefore teaches/suggests a method for controlling a haptic system, comprising: determining a target force vector to be applied to the tool;

determining respective vectors of a plurality of cables coupled to a tool with respect to the tool; determining respective tensions to be applied to the plurality of cables to apply an actual force vector to the tool, including balancing (1) a difference between the resulting actual force vector applied to the tool and the target force vector and (2) a magnitude of the tensions to be applied to the cables; and applying the determined tensions to the respective cables to apply the actual force vector (Sato, col. 4, ll. 6-56; see also col. 6, l. 6 – col. 7, l. 13) (Guy, col. 1, ll. 48-53; see also col. 12, ll. 64-67 and col. 4, ll. 55-59).

As to claim 71, Sato as modified by Guy teaches/suggests wherein the balancing the (1) difference between the actual force vector and the target force vector and (2) the magnitude of the tensions comprises selecting tensions to be applied to the plurality of cables such that the difference is close to or equal to a selected fixed value (e.g., zero) multiplied by the magnitude of the tensions (e.g., balancing) (Guy, col. 1, ll. 48-53).

As to claim 72, Sato as modified by Guy teaches/suggests wherein the balancing the (1) difference between the actual force vector and the target force vector and (2) the magnitude of the tensions comprises selecting tensions to be applied to the plurality of cables such that the difference is close to or equal to a selected fixed value (e.g., zero) multiplied by a squared value of the magnitude of the tensions (e.g., balancing) (Guy, col. 1, ll. 48-53).

As to claim 73, Sato as modified by Guy teaches/suggests wherein the selected fixed value is a stability coefficient (e.g., zero) (Guy, col. 1, ll. 48-53)

4. Claim 50 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sato and Guy as applied to claims 9, 38, 49, 51 and 60-65 above, and further in view of U.S. Patent No. 6,587,749 to Matsumoto ("Matsumoto").

As to claim 50, neither Sato nor Guy disclose wherein each of the plurality of tool translation effecter devices includes a brake configured to lock the respective tool translation effecter device while the haptic interface device is powered down, as claimed. Matsumoto discloses an electronic tool device connected to a computer, the tool device comprising a holding brake to hold the tool device's position when a power supply is turned off (e.g., powered down) (Matsumoto, col. 1, ll. 13-15).

All of the component parts are known in Sato, Guy and Matsumoto. The only difference is the combination of the "old elements" together by mounting them in a single interface device. Thus, it would have been obvious to a person having ordinary skill in the art to include a holding brake taught by Matsumoto into the modified haptic interface device as suggested by Sato and Guy, since the operation of the holding brake is in no way dependent on the operation of the other equipment of the electronic tool device, and a holding brake could be used in combination with the haptic interface device of Sato and Guy to achieve the predictable result of locking the cables when current is removed therefrom. Moreover, the suggestion/motivation for doing so would have been to prevent damage and wear-and-tear of the haptic interface by locking movement of the translation effecter device when not in use, thereby reducing maintenance of the same, as one of ordinary skill in the art would readily appreciate.

5. Claims 39, 52 and 59 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sato and Guy as applied to claims 9, 38, 49, 51 and 60-65 above, and further in view of U.S. Patent No. 6,104,380 to Stork et al. ("Stork").

As to claim 59, neither Sato nor Guy disclose a sensor array associated with the attachment point and configured to provide signals corresponding to at least one of roll, pitch, and yaw of the tool, as claimed. Stork discloses an interface device, the interface device comprising a display (10) and a hand manipulated tool (150) having a sensor array, the sensor array configured to provide and wirelessly transmit signals corresponding to at least one of roll, pitch, and yaw of the tool (Stork, col. 5, ll. 46-57).

All of the component parts are known in Sato, Guy and Stork. The only difference is the combination of the “old elements” together by mounting them within a single interface device. Thus, it would have been obvious to one having ordinary skill in the art to include the sensor array taught by Stork into the hand manipulated tool of Sato and Guy, since the operation of the sensor array is in no way dependent on the operation of the other equipment of the hand manipulated tool, and a sensor array could be used in combination with a hand manipulated tool in any interface device to achieve the predictable results of providing signals corresponding to at least one of roll, pitch, and yaw. Moreover, the suggestion/motivation for doing so would have been to provide the haptic interface device of Sato and Guy with a greater degree of sensitivity, as one of ordinary skill in the art would appreciate.

As to claim 52, Sato as modified by Guy and Stork teaches/suggests wherein the sensor array is configured to provide signals corresponding to each of a roll, a pitch, and a yaw of the tool (Stork, col. 5, ll. 46-57).

As to claim 39, Sato as modified by Guy and Stork teaches/suggests measuring rotation of the tool about one or more of three mutually perpendicular axes (Stork, col. 5, ll. 46-57).

6. Claims 12, 13, 17, 42 and 54 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sato in view of Guy and Stork.

As to claim 12, Sato is modified by Guy and Stork for the same reasons set forth in the rejection of claims 9 and 59 above, respectively, and therefore teaches/suggests a haptic device for operation by a user, comprising: a user interface tool (Sato, 10) configured to be manipulated by the user and moved within a volume of space, and including a sensor array configured to detect at least one of roll, pitch, and yaw of the user interface tool (Stork, col. 5, ll. 46-57); a first, a second, a third, and a fourth tool translation effecter device, each coupled to a support structure in positions such that the first, second, third, and fourth tool translation effecter devices define between them a tetrahedron within the volume of space, each of the tool translation effecter devices including a respective spool, a respective motor, and a respective encoder configured to provide a signal corresponding to rotation of the respective spool (Sato, Fig. 1) (Guy, col. 4, l. 67 – col. 5, l. 3; see also col. 7, ll. 12-21; col. 12, ll. 64-67); and a first, a second, a third, and a fourth cable (Sato, 12-1, 12-2, 12-3, 12-4) each having a respective first and a respective second end, the first end of each of the first, the second, the third, and the fourth cables coupled to the user interface tool and the second end of each of the first, the second, the third, and the fourth cables wound and unwound on the spool of a respective one of the tool translation effecter devices, each of the motors operable to drive the respective spool to selectively apply active tension to the respective cable (Sato, col. 4, ll. 6-56; see also col. 6, l. 6 – col. 7, l. 13) (Guy, col. 4, l. 67 – col. 5, l. 3; see also col. 7, ll. 12-21; col. 12, ll. 64-67).

As to claim 13, Sato as modified by Guy and Stork teaches/suggests wherein the sensor array is configured to detect roll, pitch, and yaw of the user interface tool (Stork, col. 5, ll. 46-57).

As to claim 42, Sato as modified by Guy and Stork teaches/suggests a processor system coupled to receive information from the sensor array and coupled to receive the signals from the respective encoders, the processor system configured to determine movement and orientation of the tool therefrom (Sato, Fig. 2) (Stork, col. 5, ll. 46-57) (Guy, col. 12, ll. 64-67).

As to claim 17, Sato as modified by Guy and Stork teaches/suggests wherein the processor system is configured to establish an initial position of the tool by retracting, in turn, each of the first, the second, the third, and the fourth cables to a known length position (e.g., retracting the tool to a starting position when no active tension is applied to the cables).

As to claim 54, Sato discloses wherein the device comprises no more than four cables (Sato, Fig. 1).

7. Claim 53 is rejected under 35 U.S.C. 103(a) as being unpatentable over Sato, Guy and Stork as applied to claims 12, 13, 17, 42 and 54 above, and further in view of Matsumoto.

As to claim 53, neither Sato, Guy or Stork disclose expressly a first, a second, a third, and a fourth brake coupled to respective ones of the first, the second, the third, and the fourth tool translation effecter devices and configured, when engaged, to prevent rotation of the spools associated with the respective tool translation effecter devices, as claimed. However, Sato, Guy and Stork is modified by Matsumoto for the same reasons set forth in the rejection of claim 50 above, and therefore teaches/suggests a first, a second, a third, and a fourth brake coupled to respective ones of the first, the second, the

third, and the fourth tool translation effecter devices and configured, when engaged, to prevent rotation of the spools associated with the respective tool translation effecter devices (Matsumoto, col. 1, ll. 13-15).

8. Claims 1-3, 57, 58 and 70-73 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sato in view of Guy and U.S. Patent No. 5,587,937 to Massie et al. ("Massie").

As to claim 1, Sato discloses a haptic interface device in Figures 1-3 to provide haptic interaction to a user manipulating a tool, the haptic interface device comprising: an attachment point (Sato, 10), a first (Sato, 12-1), a second (Sato, 12-2), a third (Sato, 12-3), and a fourth cable (Sato, 12-4), each having a first and a second end, the first end, and each coupled at respective first ends to the attachment point; a first, a second, a third, and a fourth tool translation effecter device (Sato, elements 38, 40, 44, 46 and 48 provided at anchoring points for cables 12-1, 12-2, 12-3 and 12-4) positioned relative to each other, such that each of the first, the second, the third, and the fourth tool translation effecter devices occupies a vertex of a tetrahedron (Sato, Fig. 4), each having coupled thereto the second end of a respective one of the first, the second, the third, and the fourth cables such that, as the attachment point moves, each of the first, the second, the third, and the fourth cables is retracted or paid out accordingly by the respective tool translation effecter device; and metering means (Sato, 42) for metering each of the first, the second, the third, and the fourth cables as they are retracted and paid out (Sato, col. 4, ll. 6-56; see also col. 6, l. 6 - col. 7, l. 13).

Sato does not disclose expressly wherein each tool translation effecter device includes controlling means for selectively varying an active tension on the respective cable, as claimed. Guy discloses a multiple degree of freedom force reflecting haptic interface device (Guy, Abstract), wherein instead of using mechanical linkages, gears, or

other force transmission components, the interface employs dedicated actuators fitted with capstans and corresponding cables to power rotary axes (Guy, col. 4, ll. 55-58). These cable drives provide good force transmission characteristics with low weight (Guy, col. 4, ll. 58-59). Metering means are provided for metering the cables as they are retracted and paid out (Guy, col. 12, ll. 64-67). Furthermore, Guy discloses in the background of the prior art that under appropriate conditions, the interface can resist, balance, or overcome a user input force along a degree of freedom (Guy, col. 1, ll. 48-51). The powered axis may be active, with force being varied as a function of system conditions (Guy, col. 1, ll. 51-53).

At the time the invention was made, it would have been obvious to one skilled in the art to replace each of the four passive translation effecter devices in Sato (Sato, elements 38, 40, 44, 46 and 48 provided at anchoring points for cables 12-1, 12-2, 12-3 and 12-4) and metering means with the active translation effecter device and metering means taught by Guy. Thus, the combined teachings result in an active translation effecter device (e.g., powered cables) positioned relative to each other, such that each of the first, the second, the third, and the fourth tool translation effecter devices occupies a vertex of a tetrahedron. The suggestion/motivation for doing so would have been to provide good force transmission characteristics with low weight (Guy, col. 4, ll. 58-9). Furthermore, at the time the invention was made it would have been obvious to one skilled in the art to further modify the teachings of Sato and Guy such that under appropriate conditions, the interface can resist, balance, or overcome a user input force along a degree of freedom with force being varied as a function of system conditions, as taught by Guy in discussing the background of the prior art (Guy, col. 1, ll. 48-53). As one of ordinary skill in the art would appreciate, the suggestion/motivation for doing so would have been to enhance user experience by varying a haptic force felt at the attachment point as a function of system conditions.

Although Sato as modified by Guy teaches/suggests acquiring a position of the attachment by determining a distance between each of the first, the second, the third, and the fourth tool translation effecter devices and the attachment point (Sato, col. 4, ll. 6-27) (Guy, col. 1, ll. 48-53), neither Sato nor Guy disclose expressly calculating means for calculating a force response to be applied to the attachment point at least in part on the basis of a position of the attachment point, as claimed. Massie discloses a force reflecting haptic interface employing active tension, wherein the interface calculates a force response to be applied to the attachment point at least in part on the basis of a position of the attachment point (Massie, col. 21, l. 3 – col. 22, l. 2). At the time the invention was made it would have been obvious to one skilled in the art to further modify the teachings of Sato and Guy such that calculating means were provided for calculating a force response to be applied to the attachment point at least in part of the basis of a position of the attachment point, as taught by Massie. As one of ordinary skill in the art would appreciate, the suggestion/motivation for doing so would have been to enhance user experience by varying a haptic force felt at the attachment point as a function of system conditions, wherein the system conditions are a virtual location in a non-local environment (Massie, col. 21, l. 3 – col. 22, l. 2).

As to claim 2, Sato as modified by Guy and Massie teaches/suggests wherein the controlling means of each of the first, the second, the third, and the fourth tool translation effecter devices includes a spool and a motor coupled to rotatably drive the spool, the motor and spool selectively operable to wind an unwind the second end of the respective cable; and the metering means includes: counting means for counting fractions of rotations of the spool of each of the first, the second, the third, and the fourth tool translation effecter devices; and compensating means for compensating for a change in ratio between changes in distance from each tool translation effecter device to the

attachment point and angular rotation of the respective spool (Guy, col. 4, ll. 55-58; see also col. 12, ll. 64-67; col. 13, ll. 11-17).

As to claim 57, Sato does not disclose expressly establishing means for establishing a respective distance between each of the first, the second, the third, and the fourth tool translation effecter devices and the attachment point, as claimed. Guy discloses establishing means for establishing a location of the attachment point (Guy, col. 13, ll. 11-17). At the time the invention was made it would have been obvious to one skilled in the art to further modify the teachings of Sato, Guy and Massie such that establishing means were provided to establish a location of the attachment point as taught by Guy. Thus, the combined teachings result in establishing a respective distance between each of the first, the second, the third, and the fourth tool translation effecter devices and the attachment point (i.e., establishing a location of the attachment point). The suggestion/motivation for doing so would have been to include automatic work volume calibration for initializing a position of the haptic interface when the system is energized (Guy, col. 13, ll. 11-17).

As to claim 58, Sato as modified by Guy teaches/suggests the establishing means comprises a calibration point at which the attachment point can be positioned, and from which the respective distances between each of the first, the second, the third, and the fourth tool translation effecter devices and the attachment point are known (Guy, col. 13, ll. 11-17).

As to claim 3, Sato as modified by Guy teaches/suggests wherein the establishing means includes a controller configured to direct the first tool translation effecter device to retract, during an initialization procedure, the first cable until the attachment point is at a

selected position relative to the first tool translation effecter device (Guy, col. 13, ll. 11-17).

As to claim 70, Sato is modified by Guy and Massie for the same reasons set forth in the rejection of claim 1 above, and therefore teaches/suggests a method for controlling a haptic system, comprising: determining a target force vector to be applied to the tool (Massie, col. 21, l. 3 – col. 22, l. 2); determining respective vectors of a plurality of cables coupled to a tool with respect to the tool; determining respective tensions to be applied to the plurality of cables to apply an actual force vector to the tool, including balancing (1) a difference between the resulting actual force vector applied to the tool and the target force vector and (2) a magnitude of the tensions to be applied to the cables; and applying the determined tensions to the respective cables to apply the actual force vector (Sato, col. 4, ll. 6-56; see also col. 6, l. 6 – col. 7, l. 13) (Guy, col. 1, ll. 48-53; see also col. 12, ll. 64-67 and col. 4, ll. 55-59) (Massie, col. 21, l. 3 – col. 22, l. 2).

As to claim 71, Sato as modified by Guy and Massie teaches/suggests wherein the balancing the (1) difference between the actual force vector and the target force vector and (2) the magnitude of the tensions comprises selecting tensions to be applied to the plurality of cables such that the difference is close to or equal to a selected fixed value (e.g., zero) multiplied by the magnitude of the tensions (e.g., balancing) (Guy, col. 1, ll. 48-53) (Massie, col. 21, l. 3 – col. 22, l. 2).

As to claim 72, Sato as modified by Guy and Massie teaches/suggests wherein the balancing the (1) difference between the actual force vector and the target force vector and (2) the magnitude of the tensions comprises selecting tensions to be applied to the plurality of cables such that the difference is close to or equal to a selected fixed value

(e.g., zero) multiplied by a squared value of the magnitude of the tensions (e.g., balancing) (Guy, col. 1, ll. 48-53) (Massie, col. 21, l. 3 – col. 22, l. 2).

As to claim 73, Sato as modified by Guy and Massie teaches/suggests wherein the selected fixed value is a stability coefficient (e.g., zero) (Guy, col. 1, ll. 48-53)

9. Claims 5-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sato, Guy and Massie as applied to claims 1-3, 57, 58 and 70-73 above, and further in view of Stork.

As to claim 7, neither Sato, Guy nor Massie disclose a sensor array at the attachment point configured to provide signals corresponding to an orientation of the attachment point, as claimed. Stork discloses an interface device, the interface device comprising a display (10) and a hand manipulated attachment point (150) having a sensor array at the attachment point, the sensor array configured to provide and wirelessly transmit signals corresponding to an orientation of the attachment point (Stork, col. 5, ll. 46-57).

All of the component parts are known in Sato, Guy, Massie and Stork. The only difference is the combination of the "old elements" together by mounting them within a single interface device. Thus, it would have been obvious to one having ordinary skill in the art to include the sensor array taught by Stork into the hand manipulated tool of Sato and Guy, since the operation of the sensor array is in no way dependent on the operation of the other equipment of the hand manipulated attachment point, and a sensor array could be used in combination with a hand manipulated attachment point in any interface device to achieve the predictable results of providing signals corresponding to an orientation of the attachment point. Moreover, the suggestion/motivation for doing so

would have been to provide the haptic interface device of Sato and Guy with a greater degree of sensitivity, as one of ordinary skill in the art would appreciate.

As to claim 8, Sato as modified by Guy, Massie and Stork teaches/suggests wherein the sensor array is configured to provide signals corresponding to roll, pitch, and yaw of the attachment point (Stork, col. 5, ll. 46-57).

As to claim 5, Sato as modified by Guy, Massie and Stork teaches/suggests wherein the establishing means includes a sensor configured to sense, independent of the first tool translation effecter device, a position of the attachment point relative to the first tool translation effecter device (e.g., roll, pitch, and yaw relative to a vertex of the tetrahedron).

As to claim 6, Sato as modified by Guy, Massie and Stork teaches/suggests wherein the establishing means includes means for reestablishing the distance from time to time during operation (e.g., reenergizing the system) (Guy, col. 13, ll. 11-17).

10. Claims 14, 15, 26-28, 67 and 68 are rejected under 35 U.S.C. 103(a) as being unpatentable over Sato, Guy and Stork as applied to claims 12, 13, 17, 42 and 54 above, and further in view of Massie.

As to claim 14, neither Sato, Guy or Stork disclose expressly a processor system coupled to receive the signals from the respective encoders, the processor system configured to determine movement of the tool therefrom, to determine a force vector to be applied to the user interface tool, and to determine an amount of active tension to be applied by a motor of each of the tool translation effecter devices to produce the determined force response, as claimed. However, Sato, Guy and Stork is modified by

Massie for the same reasons set forth in the rejection of claim 1 above, respectively, and therefore teaches/suggests a processor system coupled to receive the signals from the respective encoders, the processor system configured to determine movement of the tool therefrom (Sato, Fig. 2) (Guy, col. 12, ll. 64-67), to determine a force vector to be applied to the user interface tool, and to determine an amount of active tension to be applied by a motor of each of the tool translation effecter devices to produce the determined force vector (Massie, col. 21, l. 3 – col. 22, l. 2).

As to claim 15, Sato does not disclose expressly wherein the processor system is configured to compensate for changes in effective diameter of the spools of the first, the second, the third, and the fourth tool translation effecter devices due to changing thickness of cable on each of the spools as the respective cable is wound and unwound from the respective tool, as claimed. Guy discloses compensating for changes in effective diameter of the spools in a translation effecter device due to changing thickness of cable on a spool as the cable is wound and unwound from the tool (Guy, col. 4, l. 67 – col. 5, l. 3; see also col. 7, ll. 12-21). At the time the invention was made it would have been obvious to one having ordinary skill in the art to further modify the teachings of Sato, Guy, Stork and Massie such that compensating means was provided, as taught by Guy. The suggestion/motivation for doing so would have been to limit slippage as the cables are wound and unwound (Guy, col. 4, l. 67 – col. 5, l. 3; see also col. 7, ll. 12-21).

As to claim 26, Sato as modified by Guy, Stork and Massie teaches/suggests wherein the processor system is configured to maintain a virtual environment within which the user interface tool is operated, and to apply the force vector as feedback from the virtual environment to the user interface tool (Massie, col. 21, l. 3 – col. 22, l. 2).

As to claim 27, Sato as modified by Guy, Stork and Massie teaches/suggests a remote tool (e.g., graphic on display), and wherein the processor system is configured to control operation of the remote tool in accordance with the movement and orientation of the user interface tool (Sato, col. 6, l. 30 0 col. 7, l. 41) (Massie, col. 21, l. 3 – col. 22, l. 2).

As to claim 28, Sato as modified by Guy, Stork and Massie teaches/suggests wherein the processor system is configured to apply the force vector as feedback from the remote tool to the user interface tool (Massie, col. 21, l. 3 – col. 22, l. 2).

As to claims 67 and 68, Sato as modified by Guy, Stork and Massie teaches/suggests wherein the processor system is configured to determine the amount of active tension to be applied using an optimization process to minimize an objective function, wherein the objective function of the optimization process is a sum of (1) a different between the force vector to be applied and a target force vector and (2) a product derived from a plurality of factors, at least one of which is the amount of active tension to be applied by the motor of each of the tool translation effecter devices (e.g., balancing) (Guy, col. 1, ll. 48-53).

ALLOWABLE SUBJECT MATTER

11. Claims 18-25, 29, 30 and 33 are allowed.

As to claim 18, a statement of reasons for indication of allowable subject matter can be found in a prior Office action. As to claim 29, the prior art of record fails to teach or suggest a method of applying a selectively variable active tension to each of a plurality of cables; establishing an initial length of cable between a tool and each of the anchor points; locking, during a shutdown procedure, each of the plurality of cables at the respective anchor point; storing, after the locking and before completing the shutdown

procedure, a value indicative of a known length of each of the cables in a memory; and recovering the value indicative of the known length of each of the cables from the memory during a startup procedure, as claimed.

12. Claims 4, 55 and 66 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

RESPONSE TO ARGUMENTS

13. Applicant's arguments filed with respect to claims 1-9, 12-15, 17-30, 33, 38, 39, 42, 49-55 and 57-69 have been fully considered but they are not persuasive.

Applicant argues that to modify Sato by incorporating active control of its instruction point, as taught by Guy, would change Sato's principle of operation, and would require that Sato's simpler principle of passive position control be discarded (Amend., pp. 3-4). Furthermore, applicant argues that modification of Sato's system to provide active force feedback as taught by Guy would require a significant change of Sato's principle of operation, and would eliminate many of the advantages that Sato provides over systems like that taught by Guy (Amend., pp. 4-5).

Examiner respectfully disagrees. Sato's abstract establishes the principle of operation of the input apparatus using three-dimensional image:

> An instruction point is movably provided in a three-dimensional space and can be freely moved by a finger tip of an operator. When the operator moves the instruction point to a desired position in the three-dimensional space and selects an arbitrary point, a three-dimensional position of the instruction point is measured and is input to a three-dimensional input apparatus. an image object is displayed in the three-dimensional space on the basis of image object information which has been previously stored.

No criticality has been given to the passive position control in realizing Sato's principle of operation. Examiner respectfully submits that Sato's principle of operation will not be affected by implementing active tension as taught by Guy since Sato's input apparatus using three-dimensional image would still be able to operate as expected.

Applicant argues that Sato teaches away from a combination with Guy because Sato uses a passive system whereas Guy uses an active system (Amend., pp. 5-6). Examiner respectfully disagrees and submits that Sato is absent any language that expressly teaches against the use of an active tension system as taught by Guy.

Applicant argues that the Sato as modified by Guy fails to teach a plurality of tool translation effecter devices, each having coupled thereto a second end of a respective one of the plurality of cables, as claimed (Amend., pp. 6-8). Examiner respectfully disagrees. As noted in the rejections above, Sato discloses a haptic interface device to provide haptic interaction to a user manipulating a tool, the haptic interface device comprising: an attachment point (Sato, 10) configured to receive the tool; a plurality of not more than four cables (Sato, 12-1, 12-2, 12-3, 12-4), each cable coupled to a respective firs tend to the attachment point; and a plurality of tool translation effecter devices (Sato, elements 38, 40, 44, 46 and 48 provided at anchoring points for cables 12-1, 12-2, 12-3 and 12-4), each having coupled thereto a second end of a respective one of the plurality of cables such that, as the attachment point moves relative to that tool translation effecter device, the cable coupled thereto is retracted or paid out accordingly, and to meter the cable as it is retracted and paid out (Sato, col. 4, ll. 6-56; see also col. 6, l. 6 – col. 7, l. 13).

Sato does not disclose expressly wherein each tool translation effecter device is configured to selectively vary an active tension on the cable coupled thereto, as claimed. Guy discloses a multiple degree of freedom force reflecting haptic interface device (Guy, Abstract), wherein instead of using mechanical linkages, gears, or other force

transmission components, the interface employs dedicated actuators fitted with capstans and corresponding cables to power rotary axes (Guy, col. 4, ll. 55-58). These cable drives provide good force transmission characteristics with low weight (Guy, col. 4, ll. 58-59). Metering means are provided for metering the cables as they are retracted and paid out (Guy, col. 12, ll. 64-67). Furthermore, Guy discloses in the background of the prior art that under appropriate conditions, the interface can resist, balance, or overcome a user input force along a degree of freedom (Guy, col. 1, ll. 48-51). The powered axis may be active, with force being varied as a function of system conditions (Guy, col. 1, ll. 51-53).

At the time the invention was made, it would have been obvious to one skilled in the art to replace each of the four passive translation effecter devices in Sato (Sato, elements 38, 40, 44, 46 and 48 provided at anchoring points for cables 12-1, 12-2, 12-3 and 12-4) and metering means with the active translation effecter device and metering means taught by Guy. Thus, the combined teachings resulting in an active translation effecter device (e.g., powered cables) positioned relative to each other, such that each of the first, the second, the third, and the fourth tool translation effecter devices occupies a vertex of a tetrahedron. The suggestion/motivation for doing so would have been to provide good force transmission characteristics with low weight (Guy, col. 4, ll. 58-9).

Furthermore, at the time the invention was made it would have been obvious to one skilled in the art to further modify the teachings of Sato and Guy such that under appropriate conditions, the interface can resist, balance, or overcome a user input force along a degree of freedom with force being varied as a function of system conditions, as taught by Guy in discussing the background of the prior art (Guy, col. 1, ll. 48-53). As one of ordinary skill in the art would appreciate, the suggestion/motivation for doing so would have been to enhance user experience by varying a haptic force felt at the attachment point as a function of system conditions.

Examiner respectfully submits that the references taken collectively suggest the translation effecter devices being coupled to at least a second end of the plurality of

cables since the translation effecter devices control the active tension in the cables themselves. As one of ordinary skill in the art would appreciate, they must be connected one way or another to control the tension in the cable.

Applicant argues that neither Sato, Guy, nor Massie does not disclose calculating means for calculating a force response to be applied to the attachment point at least in part on the basis of a position of the attachment point, as determined by a distance between each of the first, the second, the third, and the fourth tool translation effecter devices and the attachment point, as claimed (Amend., pp. 8-10).

Examiner respectfully disagrees. Sato as modified by Guy discloses acquiring the position of an attachment point by determining a distance between each of the first, the second, the third, and the fourth tool translation effecter devices and the attachment point (Sato, col. 4, ll. 6-27) (Guy, col. 1, ll. 48-53). Furthermore, Massie discloses calculating a force response to be applied to an attachment point based on a position of the attachment point (Massie, col. 21, l. 3 - col. 22, l. 2), thereby allowing the input device to physically exchange a force with a user in an environment local to the user (*e.g.*, active tension corresponding to position).

14. Applicant's arguments with respect to claims 70-73 have been considered but are moot in view of the new grounds of rejection.

CONCLUSION

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ALEXANDER S. BECK whose telephone number is (571)272-7765. The examiner can normally be reached on M-F, 8AM-5PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Sumati Lefkowitz can be reached on (571) 272-3638. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Dated: September 30, 2009

/Alexander S. Beck/
Examiner, Art Unit 2629